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# A landscape-level survey of feral hog impacts to natural resources of the Big Thicket National Preserve

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**Abstract:**
We conducted a survey of the impact of feral hog (*Sus scrofa*) on the natural resources of the Big Thicket National Preserve (BTNP), a unit of the National Park Service. We worked in 3 management units: Lance Rosier, Big Sandy, and Turkey Creek. Random stratified sampling was conducted to assess impacts from hog damage on resources by vegetation type at a landscape scale. Landscape features such as topography, soil moisture, soil type, and dominant vegetative cover types were used to predict hog damage. The overall damage to vegetation from hog rooting or wallowing averaged 28% within the 3 units of the BTNP. In the Big Sandy unit, floodplains had the most damage (45%), whereas flatlands were mostly impacted in the Turkey Creek unit (46%), and uplands in the Lance Rosier unit (32%). These levels of damage were more severe and widespread than previously believed and support the premise that hog damage in the BTNP parallels the increase in hog abundance over the past 20 years.

***Key words***: Big Thicket National Preserve, exotic species, feral hog, human–wildlife conflicts, National Park Service, *Sus scrofa*, wildlife damage management

**The ecological integrity** of native habitats worldwide is threatened by a diverse array of intentionally and incidentally introduced nonnative species (Pimentel et al. 2001, Courchamp et al. 2003, Strauss et al. 2006). Of those species that were introduced intentionally, perhaps none has become more widespread than variants of domesticated and feral hogs (*Sus scrofa*). At present, feral hogs are equally at home in the tropics (Sin 2007), in deserts (Adkins and Harveson 2007), in reclaimed surface mines (Mersinger and Silvy 2007), and in swamps (Kaller 2007; Engeman et al. 2007*a,* 2007*b*). Despite benefits that domesticated stocks of hogs have brought to agriculture, those hogs that have become feral cause great problems (Corn et al. 1986, Coblentz and Baber 1987, Mayer et al. 2000, Ickes et al. 2001). Today, feral hog impacts are reported to be a serious cause of concern to the agricultural industry, the preservation of natural resources, and the conservation of native species worldwide (Ditchoff and West 2007, Hartin et al. 2007, Rollins et al. 2007). When considering their high fecundity rate and adaptability to a wide range of environmental conditions, controlling and mitigating feral hog impacts have become overwhelming challenges for resource managers at landscape scales.

In the United States, feral hogs have persisted and continue to proliferate since their introduction by early European settlers (Conover 2007). Since then, feral hogs have continued to disperse throughout Texas, and conservative estimates number them between 1.5 and 2 million (Mapston 2004). If not properly managed, feral hogs in Texas have the potential to cause extensive damage to native wildlife, habitat, and agricultural resources (Rollins et al. 2007). These impacts are often compounded in regions that have a long history of feral hogs (Waithman et al. 1999). The issue of hog impacts to native flora, fauna, and habitat is particularly pertinent to areas of conservation concern, which include wildlife refuges, national forests, and national parks such as Big Thicket National Preserve (BTNP; Singer 1981).

The control of feral hogs on the BTNP depends, to a large extent, on a public recreational hunting program. Harvest data collected by park managers from the BTNP recreational hunting program suggest that numbers of hogs have increased significantly within the past 20 years (Chavarria et al. 2006). Consequently, feral hog populations throughout the preserve continue to negatively impact park resources. Although feral hog damage may be severe, little action can be taken by local governments and resource managers until the impacts are documented. The focus of this paper is to present the scope of the problem feral hogs pose to the vegetation communities of BTNP. Using a large-scale survey method, we evaluated landscape characteristics that predicted areas of hog damage.

## Study area

The BTNP, which was established in October 1974, is located north of Beaumont in the Pineywoods region of southeast Texas. The preserve is comprised of 12 units in Jefferson, Liberty, Hardin, Polk, Tyler, Jasper, and Orange counties—a combined area of about 39,322 ha, with units ranging in size from 223 to 10,452 ha. The region was originally preserved for its exceptional diversity in fauna and flora. It was considered an ecological crossroads because of its merging of the southeast swamps, pineywood forest, post-oak belt, Great Plains, and coastal prairies. The climate of the area is warm-temperate and almost subtropical, receiving 140 cm of precipitation/year (National Park Service [NPS] 1996). Vegetation patterns within the region are generally correlated with soil texture gradients ranging from fine sandy soils to very fine clays. Marks and Harcombe (1981) categorized the vegetation composition of the BTNP into 4 broad types: uplands, slopes, floodplains, and flatlands. Uplands are comprised of ridges dominated by pine forests and mixed oak-pine woodlands. They are generally composed of well-drained soils with high sand content, except in upland flats consisting of wetland savannahs where high clay content is present. Slopes form the transition zone between uplands and floodplains, with dominant vegetation generally consisting of hardwood species interspersed with pines. Like uplands, the soils of slopes drain well, but moisture holds better in the lower slopes as a result of run-off and exposure to seasonal flooding. Floodplains, with the most poorly drained soils, consist of wetland baygall or swamps and are perennially flooded, holding standing water much of the year. Hardwoods dominate floodplains. Flatlands are aggregated near floodplains and are dominated by hardwood species and a dense understory. These low-lying areas will flood seasonally, but have soils that moderately drain. This study was limited to the Big Sandy Creek, Lance-Rosier, and Turkey Creek units where the most numerous hog impacts have been reported. A brief description of these units is provided below.

### Big Sandy Creek Unit (BSU)

The BSU (5,637 ha) lies about 25.7 km east of Livingston, Texas, along Farm-to-Market Road (FM) 1276 in Polk County. Major hydrological features of this unit include Big Sandy Creek, which runs roughly north-south the entire length of the unit, and Menard Creek, which cuts through the southwest corner. The ecosystem in this unit is comprised mostly of slopes (4,720 ha), with some floodplains (519 ha) and uplands (398 ha). There are 3,581 ha available for hunting in BSU, with a limit of 400 hunting permits issued annually.

### Lance Rosier Unit (LRU)

The LRU (10,451 ha) is located approximately 8 km southwest of Kountze, Texas, east of FM 770 in Hardin County. Major hydrological features include the Little Pine Island Bayou and Black Creek drainages. Slopes comprise most of the habitat (6,193 ha), with 2,750 ha of flatlands, 1,134 ha of floodplains and 374 ha of uplands. There are approximately 8,498 ha available for hunting with a limit of 900 hunting permits issued annually.

### Turkey Creek Unit (TCU)

The TCU (3,178 ha) is located about 17 km north of Kountze, Texas, on FM 420. The major hydrological features in this unit include Turkey Creek, which divides the unit roughly north-south, Village Creek, and Hickory Creek. Vegetation types are composed of 1,694 ha of slopes, 1,069 ha of floodplains, 327 ha of uplands, and 88 ha of flatlands. No hunting is permitted within the TCU unit due to safety regulations for recreational purposes.

# Methods

## Random stratified sampling of vegetation

The extent and intensity of rooting and wallowing activities by feral hogs was surveyed from April through September 2005 in the BSU, LRU, and TCU units of the preserve. The surveys consisted of walking along strip transects comprised of fixed segments 10 m wide by approximately 1 km long. Transect locations were selected from a set of randomly generated locations using the NPS AlaskaPak Functions Pack extension random point generator in ArcView 3.2a (Environmental Systems Research Institute, Redlands, Calif.). From 24 to 40 transects were surveyed in each unit. A random stratified sample of survey segments were selected (Krebs 1999, Braun 2005) for each major vegetation type. Distance to water, park roads, oil and gas pipelines, and park recreational trails were also recorded. Half the transects were placed <50 m from major hydrological sources (i.e., creeks and rivers), while others were placed >500 m from these water sources. Likewise, half the transects were placed <50 m to a park road, while others were placed >500 m from a park road. All transect locations were buffered 100 m from the park boundary.

## Indices of hog impact sites

We used several indices to quantify feral hog damage. Sign type, especially that representing damage from hog activity, conforms to descriptions found throughout the literature. These included sightings of live hogs, tracks and feces, wallowing areas, and rooting areas.

Locations of hog signs were georeferenced with a Garmin Legend® Global Positioning System (GPS) unit. The GPS locations of hog damage were merged with the vegetation-type shapefiles in ArcView to associate the area of impact and intensity of damage within each vegetation type. We estimated the area of each patch of hog disturbance by calculating the area of a simple polygon; we multiplied the longest length of the patch by its width through the patch's center. For clarification, disturbances that were outside the strip transects were not included. Only those parts of a disturbance that were wholly continued or those within the strip transect were included in the calculations. The sum area of all patches of hog disturbance within the strip transects produced estimates of the total area impacted for a given unit of the BTNP.

An index for intensity of hog damage, hereafter referred to as Intensity Index Value (IIV), where x represents the depth of disturbance for an individual patch, was created to note 5 categories of depth of soil disturbance: 1 = 0.6 cm $< x <$ 2.5 cm, 2 = 2.5 cm $< x <$ 10 cm, 3 = 10 cm $< x <$ 20 cm, 4 = 20 cm $< x <$ 30 cm, 5 = $x >$ 30 cm. Depth of soil disturbance for each impact site was visually estimated by comparing the soil level of disturbed patches with the soil level of normal (undisturbed) areas closest to the impact site. Two to 4 points of reference within each disturbed patch were measured and averaged to provide a better estimate of depth of disturbance.

# Results

BTNP was damaged primarily from feral hog rooting in areas consisting of wetlands and hardwood bottomlands. Hog wallows were concentrated near more mesic or wet areas where major hydrological sources were present, but they also were occasionally found near ephemeral waters sources. Impact damage from tracks, where hogs seemed to have consistently traveled, also represented an extensive source of low-impact damage throughout BTNP, primarily in areas with poorly drained soils. The overall percentage of area damaged throughout the 3 units was 28%.

BSU had the highest percentage of area damaged (34%) of the 3 units we surveyed (Table 1). Of this damage, the highest proportions of damage were observed in wet and mesic sites of lower elevation. BSU floodplains had the most damage (45%), followed by slopes (35%), and then uplands (4%). TCU was the second most heavily damaged unit by feral hogs with 28% of its area being affected (Table 1). TCU flatlands had the highest proportion of damage (46%). Within TCU, slopes (27%) and floodplains (27%) received equal levels of damage. LRU had the lowest percentage of area damaged of the 3 units, with 21% (Table 1). As in the other units, most damage was concentrated in wet sites. The uplands (33%) showed the highest proportion of damage—all of which was represented by wetland pine savannah. Lower-slopes dominated by hardwood and pine represented the next highest amount of damage (21%), followed by floodplains (15%).

**Table 1.** Habitat types and survey results of percentage of area damaged by hogs within each habitat type within 3 units of the Big Thicket National Preserve.

| Unit | Habitat type | Ha | % damaged | % damaged by habitat type | Mean intensity index values (IIV) |
|---|---|---|---|---|---|
| Big Sandy | | | 34 | | 3.0 |
| | Uplands | 398 | | 4 | |
| | Slopes | 4,720 | | 35 | |
| | Floodplains | 519 | | 45 | |
| | Flatlands | | | | |
| Lance Rosier | | | 21 | | 2.5 |
| | Uplands | 374 | | 33 | |
| | Slopes | 6,193 | | 21 | |
| | Floodplains | 1,134 | | 15 | |
| | Flatland | 2,750 | | 14 | |
| Turkey Creek | | | 28 | | 2.1 |
| | Uplands | 327 | | 8 | |
| | Slopes | 1,694 | | 27 | |
| | Floodplains | 1,069 | | 27 | |
| | Flatlands | 88 | | 46 | |

Intensity Index Values (IIV) for depth of rooting were higher in more mesic and wet vegetation types. Mean IIV scores rarely exceeded 2 or 3, but scores of 4 and 5 were occasionally found near major hydrological sources, seasonal floodplains and drainages, ephemeral ponds, and in areas with soft clay-like soil substrates. BSU had the highest mean IIV scores, while TCU had the lowest (Table 1). With the exception of wetland pine savannahs, low IIV scores predominated within uplands and slopes.

## Discussion

Managment of feral hog damage to park resources is more than just a concern for preserving the aesthetics of the BTNP. Rather, it is essential for preserving the ecological integrity of the natural systems within those protected boundaries. Our study showed that 28% of the BTNP's resources were impacted by feral hog damage. These high levels of damage and a growing number of feral hogs within the preserve pose an ever-increasing threat to several threatened and endangered plants—especially those found in the floodplains of the BSU, the uplands of the LRU, and the flatlands of the TCU. Most of the damage in the 3 units consisted of large areas of low-intensity impact. Sites of high-intensity damage (high IIV) were generally localized near fresh water sources and low area (low Extent Index Value [EIV], square meters) of impact. From a management perspective, it is important to determine the soil depth subjected to feral hog rooting and wallowing. The deeper feral hogs root into the ground, the more plant roots or rhizomes are exposed to the atmosphere, leading to reduced plant growth and increased plant mortality (Bratton 1975). Exposed roots also make the plant vulnerable to mortality, either from exposure or because of subsequent herbivory by hogs or other animals upon those exposed roots. In addition, feral hog uprooting of flood debris and leaf litter, even at low to moderate intensities of impact, may adversely affect the native ecological processes of the ecosystem. Plant debris and leaf litter on the ground surface serve as protective cover for small vertebrates and invertebrates, and they also aid in the regeneration and succession of various plant species.

Indexing methods provided an efficient means of describing spatial characteristics of the species monitored at a landscape scale. When used in conjunction with a Global Information System (GIS), impact zones associated with landscape features can be used to model and predict areas damaged by hogs. Zones with high densities of hog disturbance, large areas of damage, or high severity-index values can be used by resource managers to identify feral hog hot-spots, or areas of management concern, and direct their mitigation efforts to those areas. This is particularly important for assessing the risk that hog damage poses to the conservation of sensitive biotic, abiotic, and cultural resources.

Results from this study apply to the East Texas ecoregion because feral hogs are widespread and abundant throughout similar landscapes in the region. There is a need for follow-up surveys performed at smaller scales than our study. Such surveys would increase the accuracy of measurements of the extent of feral hog damage within vegetation subtypes. Continued monitoring of impact zones over broad temporal scales is also essential to accurately document variability in hog damage and to determine how quickly damaged habitats can recover once feral hog populations are reduced (Engeman et al. 2007*a*).

The enabling legislation of the BTNP permits the use of recreational hunting only to control feral hog numbers. Before additional management approaches to controlling feral hog numbers could be considered, it was necessary to assess the severity of the problems caused by feral hogs. This study provides some of the needed data. Our results validate the extent of the problem at a landscape scale and help identify critical areas where management actions should be directed to protect sensitive resources. A more aggressive program, including permits for an extended season on feral hogs, may be needed to curb further damage to park resources.

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